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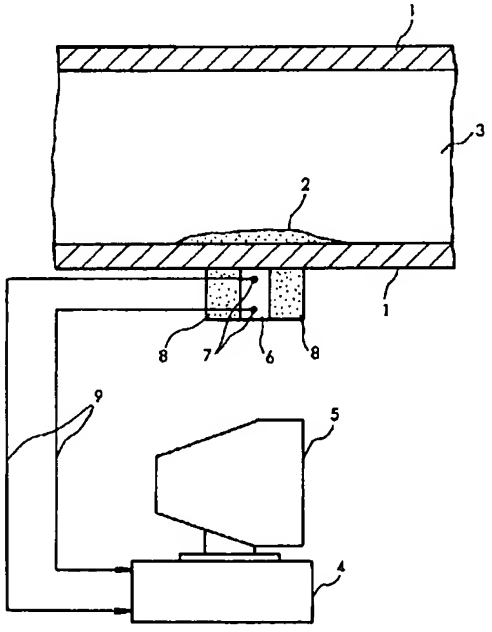
(54)【発明の名称】　管内付着物の検出装置

(57)【要約】
【構成】配管１の表面に、断熱材８で側面を断熱した金属片６を取り付け、金属片６の内部に半径方向に間隔を開けて２個の熱電対７を取り付ける。熱電対の出力信号９をパーソナルコンピュータ４に取り込む。パーソナルコンピュータ４で、２個の熱電対７の温度差を求め、その温度差が予め設定した限界値より小さくなったとき、付着物２が存在するとみなし、ディスプレイ５上に警告を表示する。
【効果】配管内の付着物を早期に検出することができ、配管系の安全性が向上する。

図　1



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【特許請求の範囲】

【請求項１】配管表面の半径方向の熱流束または温度差の測定手段と、前記測定手段によって得られたデータを処理するための手段を設けたことを特徴とする管内付着物の検出装置。

【請求項２】請求項１において、前記熱流束または温度差の検出手段は、前記検出手段の一面を強制的に冷却する構造である管内付着物の検出装置。

【請求項３】請求項１において、前記検出手段の強制冷却手段に熱電素子を用いた管内付着物の検出装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、管内付着物の検出装置に関する。

【０００２】

【従来の技術】配管内の付着物を検出する発明の公知例には以下のものがある。

【０００３】（１）加振装置により配管系を振動させ、配管系の固有振動数の変化の有無から、堆積物や付着物の増減を調べる（特開平5－164300 号公報）。

【０００４】（２）付着した灰を除去したボイラチューブの外表面にアコースティックエミッションセンサを取り付け、このボイラチューブにショットブラスト粒子を吹き付け、アコースティックセンサの出力値の変化から灰の除去を確認する（特開昭63－267896号公報）。

【０００５】（３）配管の外側からソナーによって配管内部に超音波を発信し、その反射波を受信することによりスラリ堆積状態を把握する（特開昭61－226603号公報）。

【０００６】

【発明が解決しようとする課題】前記公知例のうち（１）は配管系の慣性質量に対して付着物の質量が小さいときには、固有振動数の変化が微小となり検出が難しくなる。

【０００７】（２）は管内部に流体が流れることによって振動する場合、この振動数がアコースティックエミッションが検出する振動数に近い場合には適用できない。

【０００８】（３）は堆積物の厚さが小さい場合には反射波の位相のずれが小さくなり検出が難しい。

【０００９】本発明が解決しようとする課題は、配管の振動や付着物の容積，質量，付着厚さに影響を受けないで、配管内の付着物を検出することである。

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*【００１０】

【課題を解決するための手段】上記課題を解決するには、配管壁面の表面に、配管の半径方向の熱流束または温度差を測定するセンサを１個または複数個取り付ける。このセンサの出力を信号処理装置に入力する。

【００１１】

【作用】配管壁面に付着物があるとその部分の熱抵抗が増大し、配管壁面を流れる半径方向の熱流束は付着物が無いときに比べて小さくなる。そこで、配管表面の半径方向の熱流束または温度差をセンサによって測定し、その測定結果が予め定められた熱流束または温度差に比べて小さくなっているかどうかを信号処理装置で判定することによって配管壁面の付着物の有無を検出できる。

【００１２】

【実施例】本発明の実施例を図１ないし図４を用いて説明する。図１において１は配管であり、内部を塵挨を含んだ一定温度の高温ガス３が流れている。６は配管１とほぼ同一の熱伝導率を有する金属片であり、断熱材８を側面に設け、側面からの熱の流出を防止している。金属片６の内部には半径方向に間隔を開けて２個の熱電対７が取り付けられている。金属片６と断熱材８は配管１の表面に密着して取り付けてある。また金属片６の外側、すなわち、配管１と反対側の面は配管内部のガスに比べ充分低温の雰囲気に接している。２個の熱電対７の出力信号９はそれぞれパーソナルコンピュータ４に入力される。パーソナルコンピュータ４は一定時間毎に入力された熱電対の出力信号９から、二つの熱電対の温度差、すなわち、配管表面の半径方向温度差を求める。

【００１３】配管１の内部ガス３の温度は、金属片６の外側温度に比べて充分高いため、配管内部から管壁を通って配管外側に向かう熱の流れが生じる。金属片６が取り付けられている配管の内側に付着物２があると、一般に付着物の熱伝導率が配管の熱伝導率に比べ非常に小さいために、配管内側表面での熱抵抗が増大する。この熱抵抗の増大によって配管内部から配管外部に流れる半径方向熱流束が、付着物の無い場合に比べ小さくなる。熱流束は温度差に比例するため、結果的に配管表面の半径方向温度差が小さくなる。

【００１４】このとき、付着物による半径方向温度差の変化率ηは次式で表される。

【００１５】

【数１】

$$\eta = 1 - \left(1 + \frac{\delta 2 \lambda 1}{\delta 1 \lambda 2}\right)^{-1} \quad \cdots (数1)$$

δ１：配管の厚さ

δ２：付着物の厚さ

λ１：配管の熱伝導率

λ２：付着物の熱伝導率

【００１６】一般に、付着物の熱伝導率λ２は管壁の熱伝導率λ１に比べ一桁以上小さい。この場合、数１から、付着物の厚さが管壁厚さの１／１０程度であっても、半径方向温度差は付着物によって５０％以上変化す

ることが分かり、半径方向温度差を観測することによって十分付着物を検出できる。

【0017】図2はパーソナルコンピュータ4の処理手順を示したものである。まず熱電対出力信号9をコンピュータ内部に取り込み、2個の熱電対7の温度差δTを求める。次に求めたδTと予め設定された限界値との比較を行う。δTが限界値より大きいときには付着物は無いと判断し、熱電対出力信号の取り込みから処理を繰り返す。δTが限界値より小さいときには付着物があると判断し、ディスプレイ5上に警告を出力し、対策を要請する。

【0018】配管内部のガスが比較的低温の場合等、配管内部と配管外部の間の温度差が小さい場合には、図3に示すように、金属片6の外側に熱電素子10と、この熱電素子を駆動するための電源11を設ける。ここで、熱電素子10は金属片6と接している面が低温側であるとする。このような構造とすることによって、金属片6の外側は熱電素子によって常に冷却され、配管内部から外側に向かっての熱流を発生させることができる。

【0019】予想される付着位置が複数ある場合には、図4に示すように、図1，図2で示したような構造を持つ半径方向温度差の測定センサ12を複数取り付け、これらのセンサの出力信号9を逐次観測することによって、付着物の位置を特定することができる。

【0020】

【発明の効果】本発明によれば、配管内の付着物を早期に検出することができ、運転停止や機器損傷などの大事に至る前に対策を打つことができる。また、付着物の位置を特定できるため、メインテナンス性を大幅に向上することができる。

【図面の簡単な説明】

【図1】配管内を高温のガスが流れる場合の本発明の実施例の説明図。

【図2】熱電対出力を処理するパーソナルコンピュータの処理手順を示すフローチャート。

【図3】配管内外の温度差が小さい場合の本発明の実施例の説明図。

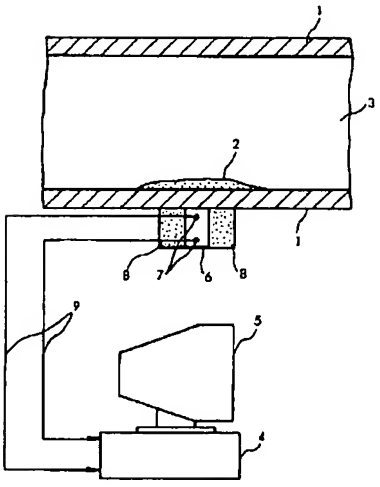
【図4】付着物の位置を特定するための本発明の実施例の説明図。

【符号の説明】

1…配管、2…付着物、3…高温ガス、4…パーソナルコンピュータ、5…ディスプレイ、6…金属片、7…熱電対、8…断熱材、9…熱電対の出力信号。

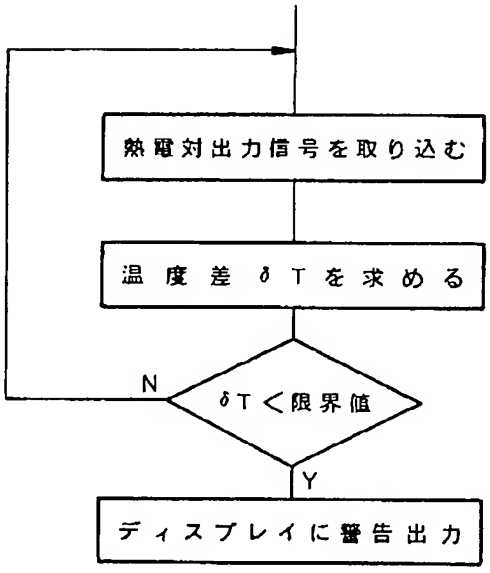
【図1】

図 1



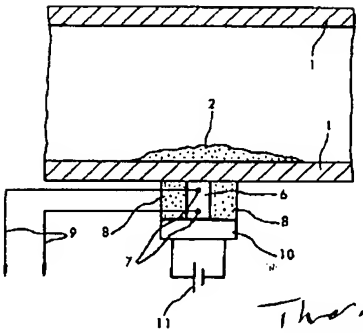
【図2】

図 2



【図3】

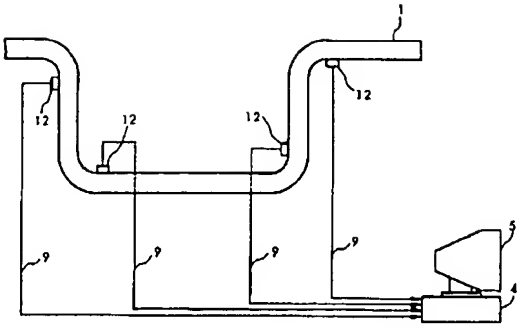
図 3



Thermal element

【図4】

図 4



PATENT ABSTRACTS OF JAPAN

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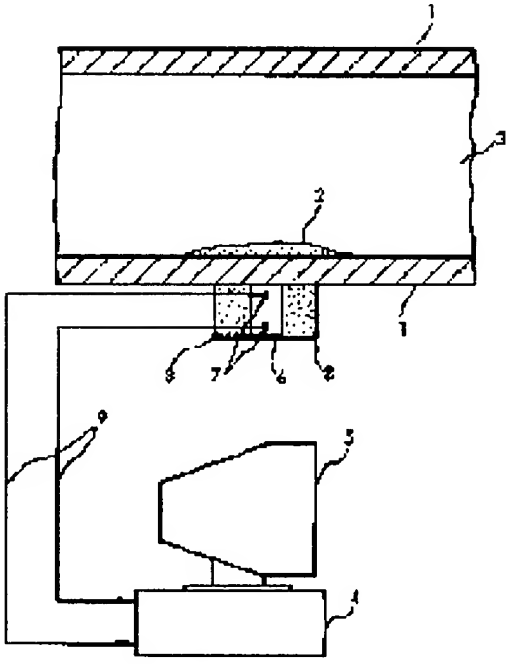
(22)Date of filing : 22.02.1994

(71)Applicant : HITACHI LTD
(72)Inventor : NISHIHARA YOSHIHIRO
KAWABE RYUHEI

(54) DEVICE FOR DETECTING PIPE INSIDE DEPOSIT

(57)Abstract:
PURPOSE: To contrive the improvement of safety of a piping system by early detecting pipe inside deposits.
CONSTITUTION: A metal piece 6 of which side is heat-insulated with a heat insulator 8, is mounted on the surface of piping 1, and two thermocouples 7 are attached to the inside of the metal piece 6 with intervals in the radius direction. Output signals 9 of the thermocouples 7 are taken in a personal computer 4. A temperature difference between the two thermocouples 7 is found, when its temperature difference is smaller than a



preset limit point, the personal computer 4 judges presence of deposits 2 and an alarm is indicated on a display 5.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] Detection equipment of the affix in tubing characterized by establishing thermal flux radial [on the front face of piping] or the measurement means of a temperature gradient, and the means for processing the data obtained by said measurement means.
[Claim 2] It is detection equipment of the affix in tubing which is the structure where said thermal flux or the detection means of a temperature gradient cools the whole surface of said detection means compulsorily in claim 1.
[Claim 3] Detection equipment of the affix in tubing which used the thermoelement for the forced-cooling means of said detection means in claim 1.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the detection equipment of the affix in tubing.
[0002]
[Description of the Prior Art] There are the following in the well-known example of invention which detects the affix in piping.
[0003] (1) Vibrate the pipe line with excitation equipment and investigate the change in a deposit or an affix from the existence of change of the resonant frequency of the pipe line (JP,5-164300,A).
[0004] (2) Attach an acoustic emission sensor in the outside surface of a boiler tube which removed adhering ashes, spray a shot-blasting particle on this boiler tube, and check ashy removal from change of the output value of an acoustic sensor (JP,63-267896,A).
[0005] (3) Send a supersonic wave to the interior of piping by sonar from the outside of piping, and grasp a slurry deposition condition by receiving the reflected wave (JP,61-226603,A).
[0006]
[Problem(s) to be Solved by the Invention] Among said well-known examples, it becomes minute, when the mass of an affix is small to the inertial mass of the pipe line changing [of a resonant frequency] (1), and detection becomes difficult.
[0007] (2) cannot be applied when this frequency is close to the frequency which acoustic emission detects when a fluid flows inside tubing and it vibrates.
[0008] When the thickness of a deposit is small, the phase shift of a reflected wave becomes small and detection is difficult for (3).
[0009] The technical problem which this invention tends to solve is detecting the

affix in piping without receiving effect in vibration of piping, the volume of an affix, mass, and adhesion thickness.

[0010]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, one or more sensors which measure the radial thermal flux or the radial temperature gradient of piping are attached in the front face of a piping wall surface. The output of this sensor is inputted into a signal processor.

[0011]

[Function] If an affix is in a piping wall surface, the thermal resistance of the part will increase, and the radial thermal flux which flows a piping wall surface becomes small compared with the time of there being no affix. Then, the radial thermal flux or the radial temperature gradient on the front face of piping is measured by the sensor, and the existence of the affix of a piping wall surface can be detected by judging with a signal processor whether the measurement result is small compared with the thermal flux or the temperature gradient defined beforehand.

[0012]

[Example] The example of this invention is explained using drawing 1 thru/or drawing 4 . In drawing 1 , 1 is piping and the elevated-temperature gas 3 of the constant temperature containing **** is flowing the interior. 6 is a piece of a metal which has the almost same thermal conductivity as piping 1, formed the heat insulator 8 in the side face, and has prevented the outflow of the heat from a side face. Spacing is opened in the interior of the piece 6 of a metal radial, and two thermocouples 7 are attached. The piece 6 of a metal and the heat insulator 8 are stuck and attached in the front face of piping 1. Moreover, the field of the outside of the piece 6 of a metal, i.e., piping 1 and the opposite side, is in contact with the low-temperature ambient atmosphere enough compared with the gas inside piping. The output signal 9 of two thermocouples 7 is inputted into a personal computer 4, respectively. From the output signal 9 of the thermocouple inputted for every fixed time amount, a personal computer 4 searches for the temperature gradient of two thermocouples, i.e., the radial temperature gradient on the front face of piping.

[0013] Since it is sufficiently high compared with the outside temperature of the piece 6 of a metal, the heat flow which goes to a piping outside through a tube wall from the interior of piping produces the temperature of the internal gas 3 of piping 1. If an affix 2 is inside piping in which the piece 6 of a metal is attached, since it is very small compared with the thermal conductivity of piping, generally the thermal resistance in a piping inside front face will increase [the thermal

conductivity of an affix]. The radial thermal flux which flows from the interior of piping to the piping exterior becomes small compared with the case where there is no affix, according to increase of this thermal resistance. Since thermal flux is proportional to a temperature gradient, the radial temperature gradient on the front face of piping becomes small as a result.

[0014] At this time, the rate of change eta of the radial temperature gradient by the affix is expressed with a degree type.

[0015]

[Equation 1]

$$\eta = 1 - \left(1 + \frac{\delta 2 \lambda 1}{\delta 1 \lambda 2}\right)^{-1} \quad \cdots (数1)$$

δ1：配管の厚さ

δ2：付着物の厚さ

λ1：配管の熱伝導率

λ2：付着物の熱伝導率

[0016] Generally, the thermal conductivity lambda 2 of an affix is small single or more figures compared with the thermal conductivity lambda 1 of a tube wall. In this case, from several 1, even if the thickness of an affix is about [of tube wall thickness] 1/10, it turns out that it changes with affixes 50% or more, and a radial temperature gradient can detect an affix enough by observing a radial temperature gradient.

[0017] Drawing 2 shows the procedure of a personal computer 4. The thermocouple output signal 9 is first incorporated inside a computer, and it asks for temperature-gradient deltaT of two thermocouples 7. Next, the comparison with deltaT for which it asked, and the threshold value set up beforehand is performed. When larger than threshold value, deltaT judges that there is no affix and repeats processing from incorporation of a thermocouple output signal. deltaT judges that there is an affix, when smaller than threshold value, it outputs warning on a display 5, and demands a cure.

[0018] When the gas inside piping is low temperature comparatively and the temperature gradient between the interior of piping and the piping exterior is small, as shown in drawing 3 , the power source 11 for driving a thermoelement 10 and this thermoelement is formed in the outside of the piece 6 of a metal. Here, a thermoelement 10 presupposes that the field which is in contact with the piece 6 of a metal is a low temperature side. By considering as such structure, it is always cooled by the thermoelement and the outside of the piece 6 of a metal can generate the heat flow rate which goes outside from the interior of piping.

[0019] When there are two or more adhesion locations expected, as shown in drawing 4 , the location of an affix can be pinpointed by observing serially the output signal 9 of two or more installation and these sensors for the measurement sensor 12 of a radial temperature gradient with structure as shown by drawing 1 and drawing 2 .

[0020]

[Effect of the Invention] According to this invention, the affix in piping is detectable at an early stage, and a cure can be struck before resulting carefully [shutdown, device damage, etc.]. Moreover, since the location of an affix can be pinpointed, maintenance nature can be improved sharply.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Industrial Application] This invention relates to the detection equipment of the affix in tubing.

[Translation done.]

* NOTICES *

PRIOR ART

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[Translation done.]

* NOTICES *

TECHNICAL PROBLEM

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[Translation done.]

* NOTICES *

MEANS

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, one or more sensors which measure the radial thermal flux or the radial temperature gradient of piping are attached in the front face of a piping wall surface. The output of this sensor is inputted into a signal processor.

[Translation done.]

* NOTICES *

OPERATION

[Function] If an affix is in a piping wall surface, the thermal resistance of the part will increase, and the radial thermal flux which flows a piping wall surface becomes small compared with the time of there being no affix. Then, the radial thermal flux or the radial temperature gradient on the front face of piping is measured by the sensor, and the existence of the affix of a piping wall surface can be detected by judging with a signal processor whether the measurement result is small compared with the thermal flux or the temperature gradient defined beforehand.

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* NOTICES *

EXAMPLE

[Example] The example of this invention is explained using drawing 1 thru/or drawing 4 . In drawing 1 , 1 is piping and the elevated-temperature gas 3 of the constant temperature containing **** is flowing the interior. 6 is a piece of a metal which has the almost same thermal conductivity as piping 1, formed the heat insulator 8 in the side face, and has prevented the outflow of the heat from a side face. Spacing is opened in the interior of the piece 6 of a metal radial, and two thermocouples 7 are attached. The piece 6 of a metal and the heat insulator 8 are stuck and attached in the front face of piping 1. Moreover, the field of the outside of the piece 6 of a metal, i.e., piping 1 and the opposite side, is in contact with the low-temperature ambient atmosphere enough compared with the gas inside piping. The output signal 9 of two thermocouples 7 is inputted into a personal computer 4, respectively. From the output signal 9 of the thermocouple inputted for every fixed time amount, a personal computer 4 searches for the temperature gradient of two thermocouples, i.e., the radial temperature gradient on the front face of piping.

[0013] Since it is sufficiently high compared with the outside temperature of the piece 6 of a metal, the heat flow which goes to a piping outside through a tube wall from the interior of piping produces the temperature of the internal gas 3 of piping 1. If an affix 2 is inside piping in which the piece 6 of a metal is attached, since it is very small compared with the thermal conductivity of piping, generally the thermal resistance in a piping inside front face will increase [the thermal conductivity of an affix]. The radial thermal flux which flows from the interior of piping to the piping exterior becomes small compared with the case where there is no affix, according to increase of this thermal resistance. Since thermal flux is proportional to a temperature gradient, the radial temperature gradient on the front face of piping becomes small as a result.

[0014] At this time, the rate of change eta of the radial temperature gradient by the affix is expressed with a degree type.

[0015]

[Equation 1]

$$\eta = 1 - \left(1 + \frac{\delta 2 \lambda 1}{\delta 1 \lambda 2}\right)^{-1} \quad \cdots (数1)$$

$\delta 1$：配管の厚さ

$\delta 2$：付着物の厚さ

$\lambda 1$：配管の熱伝導率

$\lambda 2$：付着物の熱伝導率

[0016] Generally, the thermal conductivity lambda 2 of an affix is small single or more figures compared with the thermal conductivity lambda 1 of a tube wall. In this case, from several 1, even if the thickness of an affix is about [of tube wall thickness] 1/10, it turns out that it changes with affixes 50% or more, and a radial temperature gradient can detect an affix enough by observing a radial temperature gradient.

[0017] Drawing 2 shows the procedure of a personal computer 4. The thermocouple output signal 9 is first incorporated inside a computer, and it asks for temperature-gradient deltaT of two thermocouples 7. Next, the comparison with deltaT for which it asked, and the threshold value set up beforehand is performed. When larger than threshold value, deltaT judges that there is no affix and repeats processing from incorporation of a thermocouple output signal. deltaT judges that there is an affix, when smaller than threshold value, it outputs warning on a display 5, and demands a cure.

[0018] When the gas inside piping is low temperature comparatively and the temperature gradient between the interior of piping and the piping exterior is small, as shown in drawing 3 , the power source 11 for driving a thermoelement 10 and this thermoelement is formed in the outside of the piece 6 of a metal. Here, a thermoelement 10 presupposes that the field which is in contact with the piece 6 of a metal is a low temperature side. By considering as such structure, it is always cooled by the thermoelement and the outside of the piece 6 of a metal can generate the heat flow rate which goes outside from the interior of piping.

[0019] When there are two or more adhesion locations expected, as shown in drawing 4 , the location of an affix can be pinpointed by observing serially the output signal 9 of two or more installation and these sensors for the measurement sensor 12 of a radial temperature gradient with structure as shown by drawing 1 and drawing 2 .

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The explanatory view of the example of this invention in case hot gas flows the inside of piping.

[Drawing 2] The flow chart which shows the procedure of the personal computer which processes a thermocouple output.

[Drawing 3] The explanatory view of the example of this invention when the temperature gradient of piping inside and outside is small.

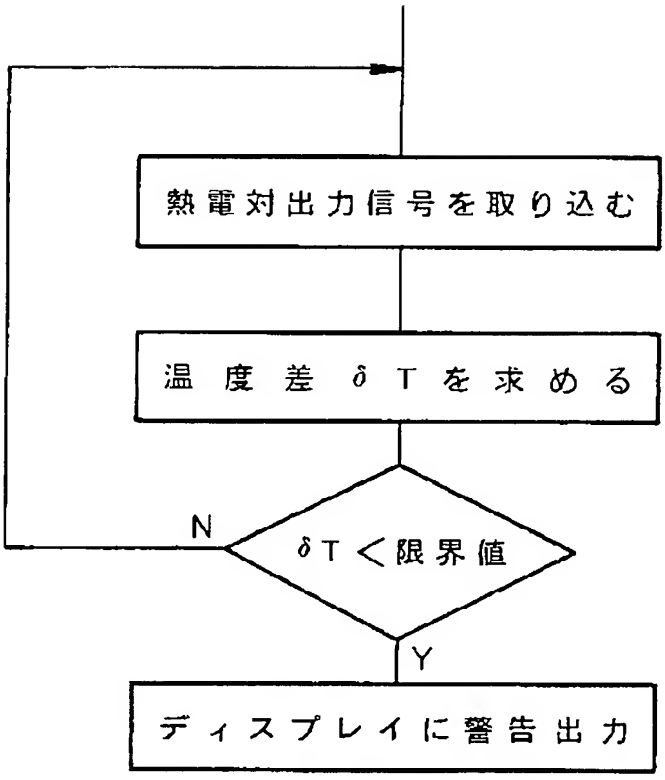
[Drawing 4] The explanatory view of the example of this invention for pinpointing the location of an affix.

[Description of Notations]

1 [-- A personal computer, 5 / -- A display, 6 / -- The piece of a metal 7 / -- A thermocouple, 8 / -- A heat insulator, 9 / -- Output signal of a thermocouple.] -- Piping, 2 -- An affix, 3 -- Elevated-temperature gas, 4

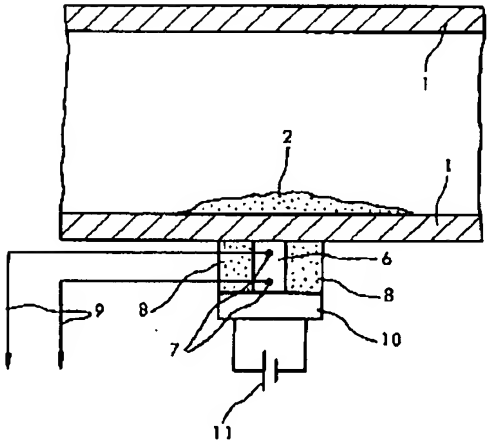
[Translation done.]

図　2



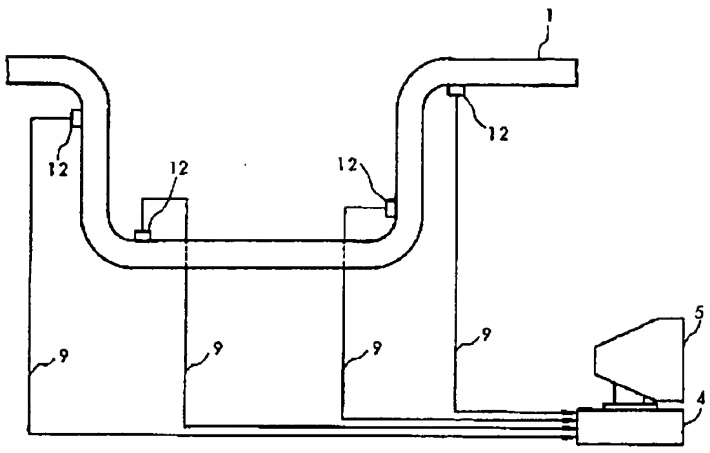
[Drawing 3]

図　3



[Drawing 4]

図 4



[Translation done.]